APH Experiments: Germination and Seedling Establishment Methods

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Advanced Plant Habitat Facility

An automated plant growth facility for conducting plant research supporting space biology and food production projects on the International Space Station.

Plants are grown in the Science Carrier (SC) of the APH, (0.2 m^2 instrumented) root module. The SC is packed with media, seeded on Earth, and transferred dry to the APH facility on ISS. The plant experiments are initiated when the SC is installed in the APH and fully wetted.

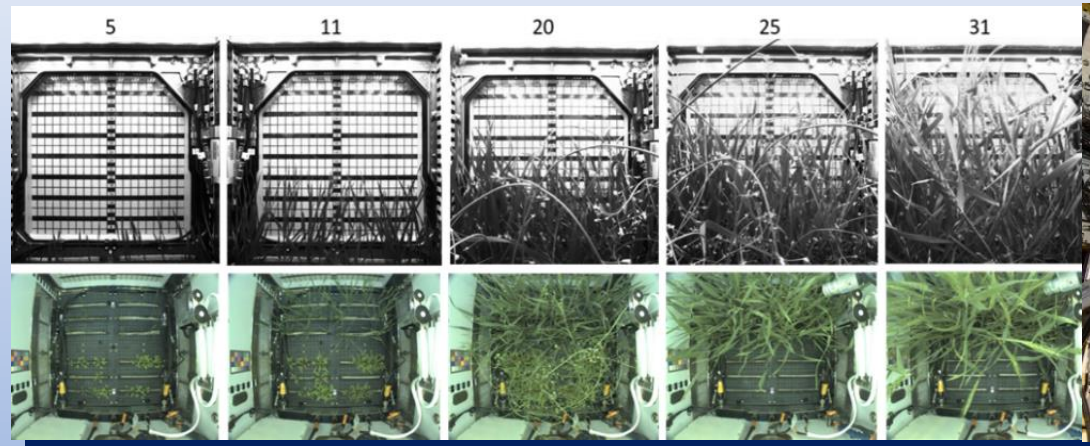
APH 1st Plant Test – Tech Demo:

- Initiated First Plant Test on 22 Jan 2018 - verify that science is supported on APH.
- Install pre-planted SC: WT Arabidopsis and Apogee semi-dwarf wheat
- Two week growth of WT Arabidopsis and 33 days of wheat conducted to demonstrate adequate plant growth on APH facility.
- Demonstrate and evaluate performance of on-orbit watering protocols.

APH Literature:

Morrow et al. "A new plant habitat facility for the ISS," ICES-2016-320, 2016.
Monje et al. "Hardware Validation of APH on ISS: Canopy Photosynthesis in reduced gravity", Frontiers in Plant Science 2020.

APH Experiments on ISS



APH 1st Plant Test - Technology Demonstration – Hardware and Science Validation

Monje et al, Frontiers Plant Sci 2020

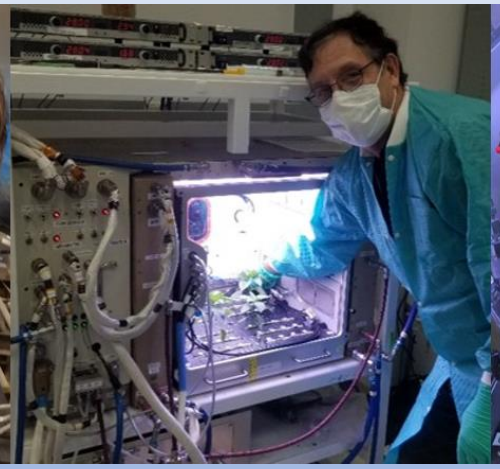
PH-01 - PI: Norman Lewis - An Integrated Omics Guided Approach to Lignification and Gravitational Responses: The Final Frontier

PH-02 – PI: Karl Hasenstein – Assessment of Nutritional Value and Growth Parameters of Space-grown Plants - Radish

New life support concepts must be demonstrated to sustain large crew sizes in cislunar space.

APH Experiment Ground Studies





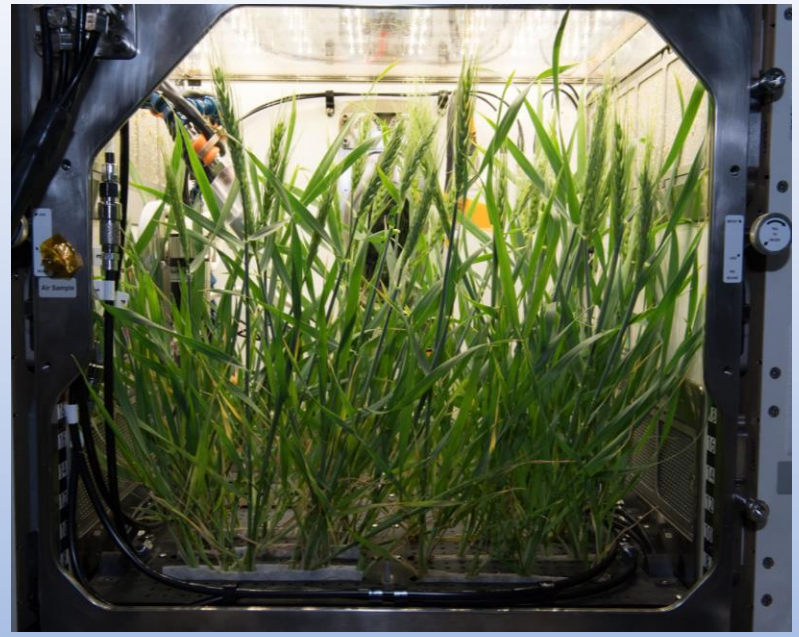
PH-04 PI: Matthew Romeyn - Technology Demonstration
Growth of New Mexico Hatch Green Chile as a Technical Display of APH's Capabilities Ground Testing

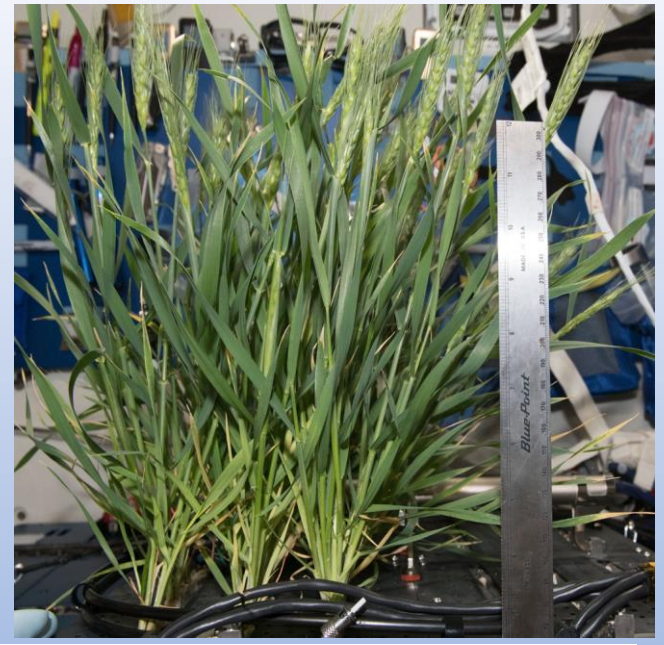
PH-04: Ground Studies

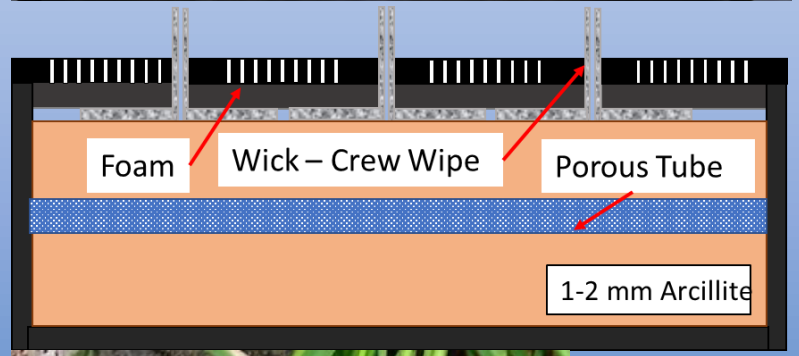
- Lighting/Spectrum/Photoperiod
  - Lighting affects physiology
- Environmental set points
- Seed germination
- Media and fertilizer
- Crop moisture requirements
- Pollination Method
- Seed cultivars and Sanitization
- Light Recipe - optimal spectral quality
  - Control plant height with high blue ratios
  - Green light reduces intumescence (leaf lesions)
- Elevated CO_2 increases intumescence
- Wicking configurations affect germination, emergence and seedling viability
- Optimize time release fertilizer amount
- Consult NM growers ; Determine upper and lower moisture limits by wilting test
- Two options - cycling of fan speed and manual tapping of flowers
- Cultivar selection ; Verified germination and seed sanitization protocols

Germination and Seed Establishment

- The APH uses granular media that is fertilized with slow release fertilizer pellets. Seeds were sanitized and their germination was tested prior to use in the SC.
- Seedling Establishment: affected by media moisture content, chamber humidity or if salt buildup near the seeds was permitted. Thus, germination was carried in media that was flooded and drained, in a chamber held at 80% relative humidity at a low wind speed of 0.3 m/s. After a week the humidity was lowered to 60% RH and wind speed was increased to 0.6 m/s.
- The germination of different plant species (*Arabidopsis*, wheat, radish and peppers) were found to respond differently to planting systems, as well as fertilization rates.

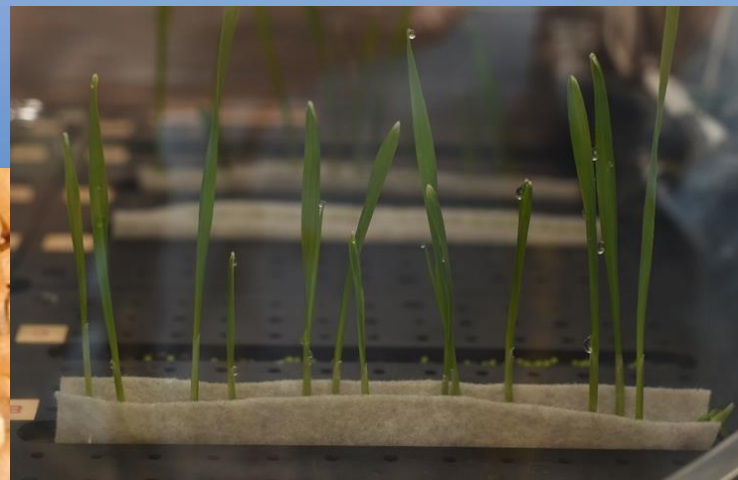


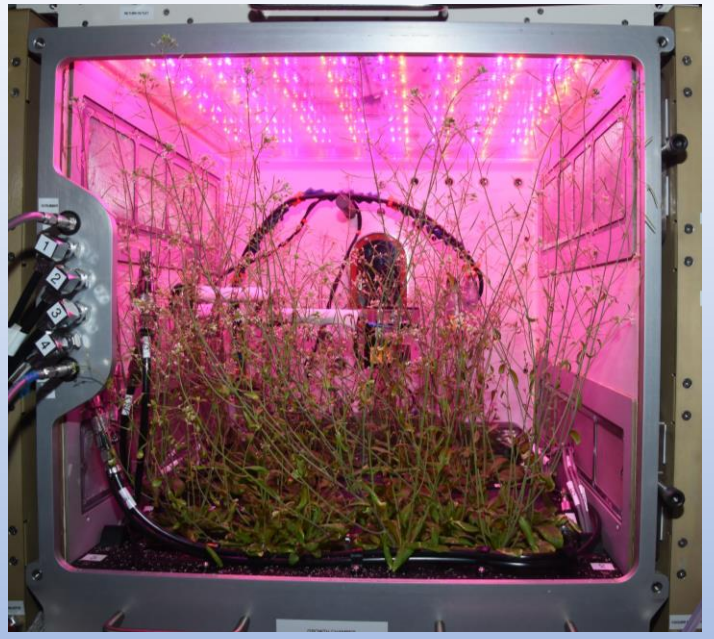


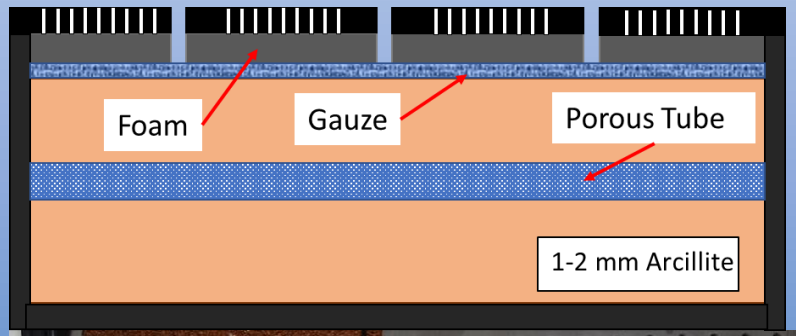


Wheat Planting System

- Legacy from PESTO on BPS
- Foam/Wick contain media
- Seeds pressed by foam

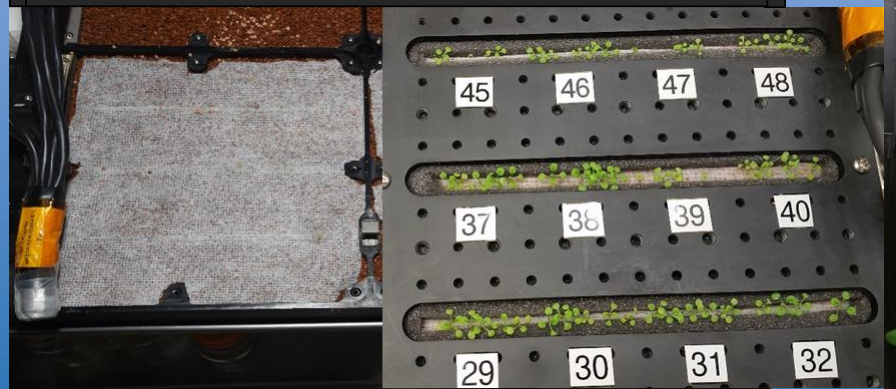


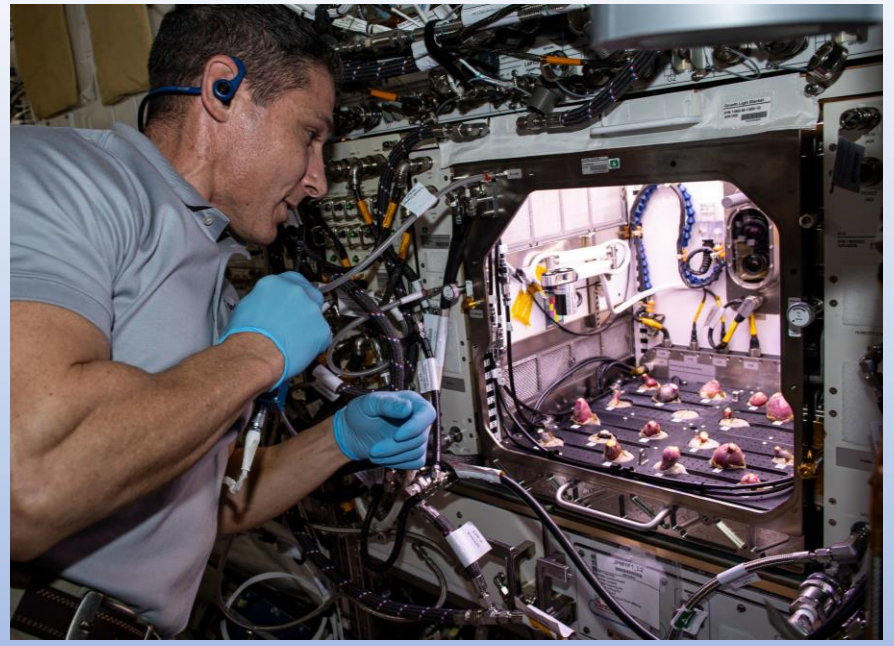


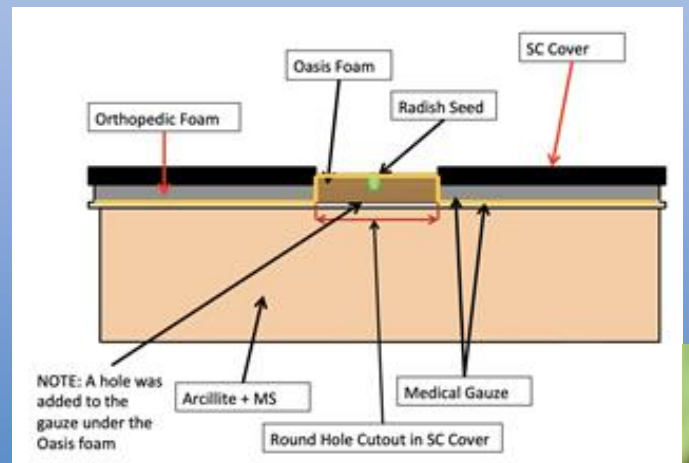


Arabidopsis Planting System

- Many configurations tested
- Foam/Gauze contain media
- Seeds glued with guar gum

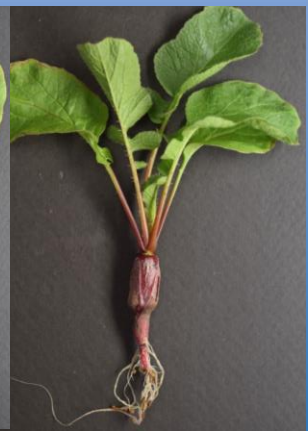


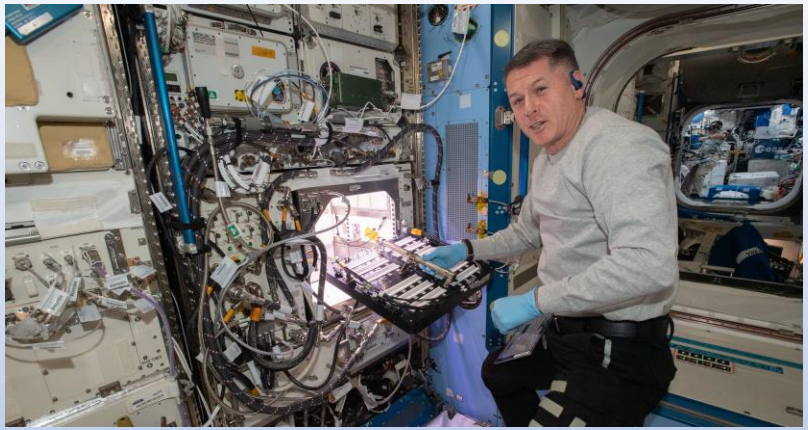


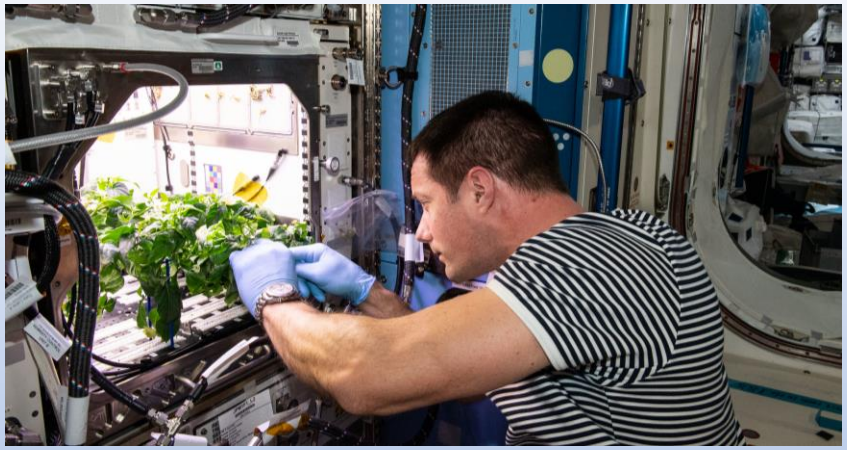


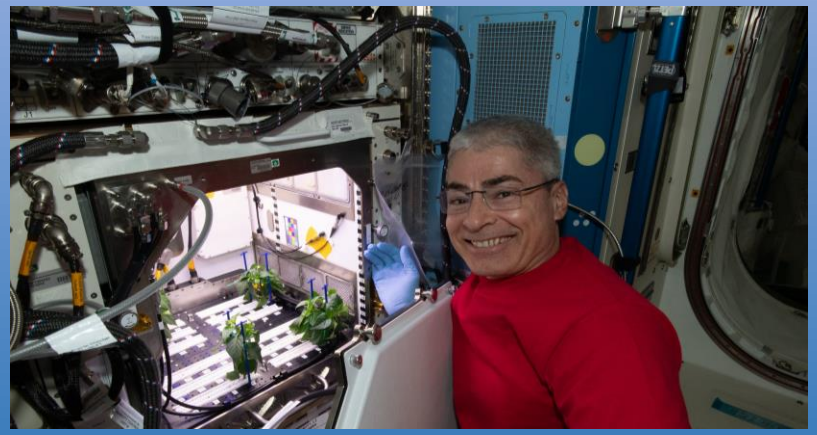
Radish Planting System

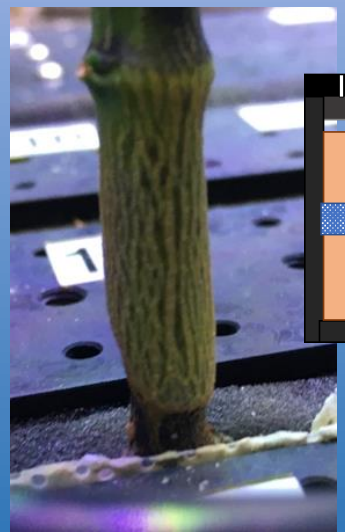
- PI derived Many configurations tested
- Foam/Gauze contain media
- Modified covers for radish bulbs

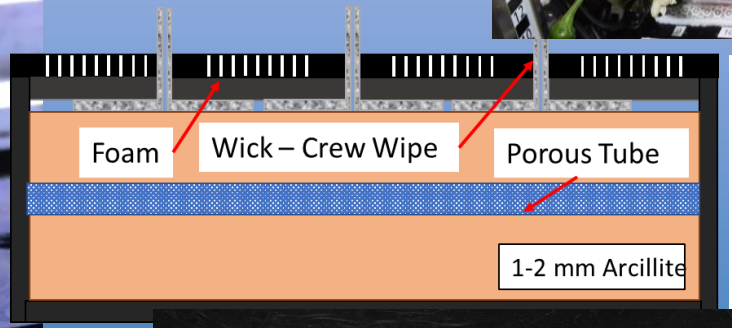


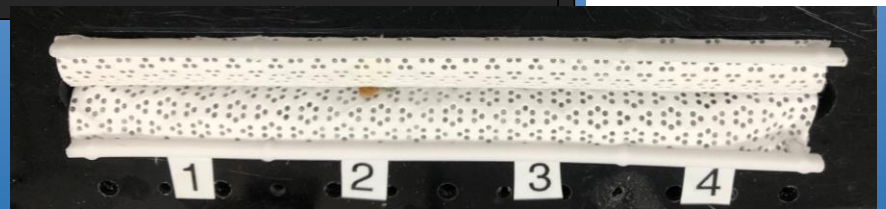












Pepper Planting System

- Modified wheat - salt
- Foam/Wick contain media
- Seeds glued with guam guar

Questions?

Acknowledgments

This work was funded by NASA's Biological and Physical Sciences Division and NASA's ISS Program.